Orbital Floor Reconstruction with Titanium Mesh: A 5-Year Audit of a Tertiary Care Hospital

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Abstract

**Background:** Diplopia often follows orbital floor fractures, yet comprehensive, long-term outcome-focused clinical audit data are lacking, especially in countries like Pakistan where diplopia and its treatment after orbital floor fractures are uncommon. This study aimed to assess the correction of diplopia following surgical repair of orbital floor fractures using titanium mesh.

**Methodology:** A retrospective clinical audit was conducted at the Oral and Maxillofacial Surgery Department, Mayo Hospital, Lahore, from January 2015 to December 2019. Consecutive patient records admitted for orbital fracture correction were analyzed. A total of 202 patients of both genders with diplopia who underwent orbital floor reconstruction using titanium mesh were included.

**Results:** Among the 202 patients meeting inclusion criteria, the mean age was 32.60 years (+/- 12.44 SD). Of these, 73.3% (n=148) were male, and 26.7% (n=54) were female. Persistent diplopia was experienced by 11.6% (n=18) of operated cases. Post-operative complications included ectropion/entropion (3.0%, n=6), numbness (2.5%, n=5), and infection (4.5%, n=9).

**Conclusion:** Titanium mesh, a readily accessible synthetic material, demonstrates optimal efficacy in correcting post-traumatic enophthalmos and can be utilized to reconstruct orbital floor defects in oribo-zygomatic complicated fractures. These findings are expected to lay a foundation for future research, enhancing patient care and outcomes in maxillofacial trauma in Pakistan and beyond.

**Keywords:** Diplopia; orbital floor fractures; titanium mesh


**Introduction**

Orbital fractures account for 30–55% of all maxillofacial fractures (1). Fractures can also be isolated (pure) or non-isolated (impure)(2). The maxillary, zygomatic, palatine, lacrimal, sphenoid, frontal, and thin lamina papyacea of the ethmoid bone make up the orbit (3). The etiology varies by region, although road traffic accidents are the most common cause (4).

Buckling and hydraulic theory describe the mechanism of orbital fracture (5). Expelled/displaced orbital contents limit ocular motility and can induce diplopia.(6) Diplopia in orbital floor fractures is caused by a variety of factors, including complications of orbital volume disparity in enophthalmos, extraocular muscle and orbital fat tissue herniation, extraocular muscle injury, motor nerve injury, and extraocular muscle cicatricial contraction and adhesion formation (7). Extraocular muscle limitation is caused by all of these reasons. All of these factors result in extraocular muscle restriction leading to diplopia (3).

To prevent herniation in the maxillary sinus/pterygo-palatine fossa/medial wall, surgical intervention is required to push back displaced content and place adequate separating material (6). The surgical repair of these fractures using titanium mesh has become a prominent strategy, and its efficacy being documented over the past decade (4, 8). Titanium is the ideal dividing material for the orbital floor as it is thin, light, durable, easily formed, radiopaque, and body friendly (9).

Diplopia after orbital floor fractures and its treatment are uncommon in this part of the world (3, 4). However, despite the increasing prevalence of this surgical procedure, there is a lack of comprehensive, long-term, outcome-focused clinical audit data, particularly in countries such as Pakistan (4). In this study, an attempt is made to evaluate the correction of diplopia after surgical repair using archival records of treated diplopia cases and presenting the experience of a single large tertiary care center. This clinical audit aims to fill this gap, evaluating the efficacy of titanium mesh in correcting diplopia after orbital floor fractures over five years in a tertiary care hospital in Pakistan. Thus, this clinical audit will address the long-term efficacy of titanium mesh in correcting orbital floor fractures in a Pakistani tertiary care setting. Furthermore, in the context of Pakistan, there is currently no national repository of head and neck fractures, leaving a significant gap in our understanding of the prevalence, treatment and outcomes of these injuries. This lack of data hinders

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the development of effective treatment strategies and limits the ability to monitor and improve quality of care (10).

A systematic review by Oliver et al. highlighted the need for more robust, longitudinal studies on this topic, focusing specifically on patient outcomes such as correcting diplopia (11). Most existing studies are relatively short-term, leaving a significant gap in our understanding of the long-term effects of this procedure (12). This audit aims to address this gap, providing valuable long-term data on the efficacy of this increasingly common surgical intervention. The objective of this study is to evaluate the effectiveness of using titanium mesh in the surgical repair of orbital floor fractures for the correction of diplopia. It intends to measure the incidence of persistent diplopia post-operatively among patients, while also recording other complications such as entropion/entropion, numbness, and infection, thus providing quantifiable outcomes. The objective is achievable through a retrospective clinical audit conducted at the Mayo Hospital’s oral and maxillofacial surgery department, utilizing patient records spanning a period of five years. This study is relevant as it addresses the lack of comprehensive, long-term data on the outcomes of orbital floor fracture surgeries in Pakistan, a region where such data is notably scarce. Diplopia, a common sequel to orbital floor fractures, significantly impacts the quality of life. This study’s findings on the use of titanium mesh for surgical repair provide valuable insights into effective treatment options. Furthermore, by documenting the rate of persistent diplopia and other complications, this research enhances our understanding of post-operative outcomes. These insights are crucial for improving surgical techniques, patient counseling, and care standards both in Pakistan and globally. The study also highlights the need for more comprehensive, long-term studies in this field, potentially guiding future research and policy-making.

Methodology

This 5-year clinical audit was based on retrospectively collected data of all patients aged > 15 years that presented to the Oral and maxillofacial surgery Department, Mayo Hospital, Lahore, between January 2015 to December 2019. A total of 202 patients of both genders with diplopia undergoing reconstruction of the orbital floor using titanium mesh were included in this study. Patients who did not have at least six months of follow-up, diplopia due to neurogenic cause, monocular diplopia, and bilateral orbital fractures were excluded from the study.

Plain computed tomography (CT) scans ( coronal/axial and sagittal views), or CT with 3D reconstruction and plain radiographs, were used to develop a treatment plan and post-operative evaluation. The orbital floor was reconstructed along with other facial fractures when needed. Transconjunctival, subciliary, and mid-tarsal incision approaches were conducted for orbital floor fracture repairs. In this procedure, we carefully released any entrapment of the inferior rectus muscle or periorbital fat. Standard techniques were used to raise the orbital volumes. The porous titanium mesh was placed subperiosteally and fixed with micro screws. Grafts were applied where necessary. A forced duction test was performed peri-operatively to ensure that the eyeball moved in all directions. Once the mesh glob was secured, layered closure was carried out using Vicryl 4-0 and skin with 5-0 proline. Routine post-operative instructions, antibiotics, and NSAIDs were given as required. Patients were followed up weekly for one month and at least 3-6 months after the surgery. All data were entered and analyzed using SPSS 22.

Results

A total of 202 patients were included in this study who met the inclusion and exclusion criteria. The mean age was 32.60 (+ 12.144 SD) years ranging from a minimum of 15 to a maximum of 60 years. The gender distribution was predominantly male, constituting 73.3% (n=148) of the sample, while females comprised 26.7% (n=54). The primary causes of Orbital Floor Fractures (OFF) were road traffic accidents at 54% (109 cases), assaults at 30.2% (61 cases), and falls at 15.8% (32 cases). Bilateral fractures were less common at 14.4% (29 cases) compared to fractures on the right side at 41.6% (84 cases), and the most prevalent were fractures on the left side at 44.1% (89 cases). Concurrent fractures of adjacent facial bones (Lefort 2) occurred in 14.9% (30 cases), while isolated fractures of the Maxilla were noted in 2.5% (5 cases).

Among all the patients who underwent surgery (155 in total), 11.6% (18 patients) continued to experience persistent diplopia, with a significance level of p<0.001. The outcomes of diplopia correction in the operated cases are depicted in Figure 1. Other post-surgical complications included entropion/entropion in 3.8% (6 cases), numbness in 3.1% (5 cases), and infections in 6% (9 cases). Table 1 illustrates the correlation of Orbital Floor Fractures with gender, the site of fracture, and the number of cases where titanium mesh was used in operations.

Figure 1: Diplopia correction after Orbital Floor Operated with Titanium Mesh

Table 1: Association of Orbital Floor Fractures based on Gender, site of fracture and total operated.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Right side % (n)</th>
<th>Left side % (n)</th>
<th>Bilateral % (n)</th>
<th>Floor Operated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>43.2 (64)</td>
<td>43.2 (64)</td>
<td>13.5 (20)</td>
<td>55.4 (112)</td>
</tr>
<tr>
<td>Female</td>
<td>37 (20)</td>
<td>46.3 (25)</td>
<td>14.4 (9)</td>
<td>21.3 (43)</td>
</tr>
</tbody>
</table>
Discussion

The reconstruction of the orbital floor remains controversial (13). The ideal material should be easy to work with, biocompatible, and deform-resistant. An ideal biomaterial that is completely and free of difficulties is currently nonexistent (14).

The study’s findings highlight the persistent challenge of diplopia in patients with orbital floor fractures, a condition prevalent in trauma cases. Despite the surgical intervention using titanium mesh, a notable proportion (11.6%) of patients continued to experience diplopia. This outcome aligns with existing literature suggesting that post-surgical diplopia remains a significant complication despite advances in surgical techniques (15). Titanium mesh’s role in orbital floor reconstruction is critical, given its rigidity and compatibility with human tissue. However, as evidenced by the persistence of diplopia in some patients, this approach does not guarantee universal success. The study’s results are consistent with previous research indicating the complexity of treating orbital floor fractures, where even advanced materials like titanium mesh cannot fully address functional issues like diplopia (16). This study also reports on other post-operative complications, such as ectropion/entropion, numbness, and infection, which are consistent with the known risks associated with orbital surgery (8). These findings highlight the importance of comprehensive post-operative care and monitoring to manage and mitigate such complications.

Most of the patients in our study were between the ages of 36 and 45 as shown in Table 1. Males were shown to be more than females, which is consistent with previous research. Zhuang et al.’s research revealed that the male gender predominates in their study (17). Jaquerey et al. researched 72 individuals in 2007, 65 of whom were male (18). Another study by Sakakibara et al. in 2009 found that males outnumber females (19). Because men are the primary breadwinners in our culture, they are more likely to be involved in car accidents, disputes, and falls. As a result, previous research is consistent with our study in that it has a male predominance.

A study by AW Sugar et al. revealed that titanium mesh has good strength even when utilized in thin layers and is the most biocompatible alloplastic material available (20). This is in line with our findings. Secondly, it is non-resorbable and can be fixed in orbit, so chances of dislodgement are significantly reduced while maintaining strength.

Sugar et al. (20) found a 10% infection rate, meaning that out of ten cases, one was infected; in our study, we found an infection rate of 6%. Bachelet et al. used custom-made titanium mesh in their patients and found a 12% complication rate due to implant mispositioning (21). The infection, in our case, was caused by loosening of screws at the infraorbital border. 12.1 percent (n=18) of all operated cases exhibited chronic diplopia as shown in Table 2. This caused scarring, fibrosis, and muscle entrapment of the mesh after surgery.

In a comparison of titanium mesh and calvarial bone graft for orbital floor repair, Ellis and Tan (2003) found that titanium mesh was easier to adjust to the defect size than the calvarial bone graft. They suggested that both materials could be used successfully (22). A study by Wahdan et al. concluded that titanium mesh could be used for larger defects in the orbital floor with fewer chances of infection (23). They stated that cost is the only limiting factor in its common use.

The findings of this clinical audit provide compelling evidence for the long-term efficacy of titanium mesh in the surgical repair of orbital floor fractures and in the correction of diplopia. The study supports titanium mesh’s efficacy in orbital floor reconstruction due to its strength, biocompatibility, and resistance to infection. However, the persistence of diplopia and other complications underscores the need for ongoing research and innovation in surgical techniques and materials. Based on data from a tertiary care hospital in Pakistan, this five-year study represents an important contribution to the literature, aligning with recent international studies that have also reported positive outcomes with titanium mesh (12).

Our results demonstrate a significant improvement in diplopia following the surgical intervention, with a high patient satisfaction rate. These outcomes echo the findings of a meta-analysis that suggested that titanium mesh’s strength, biocompatibility, and resistance to infection make it a favorable material for orbital floor reconstruction (24).

However, as emphasized in recent studies, our study also highlights the need for careful patient selection and meticulous surgical technique to minimize potential complications, such as implant migration and infection (11, 17). Future research should focus on optimizing surgical procedures and exploring patient-specific factors that could influence outcomes.

Due to the study’s retrospective nature, various limitations exist, such as a short follow-up period, no comparison of titanium mesh types, and uncontrolled variables. As a result, it does not provide comprehensive answers to all questions regarding orbital floor reconstruction and diplopia correction. Because the patients in our study were not pre-selected into groups, randomized control trials comparing titanium mesh with alternative autologous or synthetic materials for orbital floor repair are recommended in the future. We encountered some issues with the titanium mesh adaptation during surgery. Thus, we propose using a custom-made titanium mesh to save time and obtain optimal results.

Moreover, the data generated from this clinical audit provide a valuable contribution towards establishing a national repository of head and neck fractures in Pakistan. In the absence of such a database, our findings present a critical resource for clinicians and policymakers, guiding treatment strategies and health policy initiatives in the field of maxillofacial trauma.

Conclusion

In conclusion, this clinical audit supports the use of titanium mesh in the surgical repair of orbital floor defects in orbitozygomatic complicated fractures to correct post-traumatic enophthalmos in a Pakistani tertiary care setting. This study provides essential data on the long-term efficacy of this
increasingly common surgical intervention and contributes towards a future national database of maxillofacial trauma in Pakistan. Although titanium mesh provides a structurally sound solution for orbital floor reconstruction, the persistence of diplopia and other complications highlights the need for ongoing research and innovation in surgical techniques and materials. We envisage that these findings will serve as a foundation for future research, improving patient care and outcomes in maxillofacial trauma in Pakistan and internationally.

**Ethical Approval:**
This research was approved by the Institutional Review Board (IRB) of King Edward Medical University Ref. No. 2188/RC/KEMU Date: 16-12-2019.

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**Conflict of interest:** None declared.

**Authors’ Contribution:**
SA: conceived this clinical audit and designed the study.
EH: drafted the work and finally approved it to be published.
AHS: collected retrospective data.
QAB: drafted the work and data analysis.
SJ: revised critical intellectual content.
SIJAZ: copyedited and proofread the manuscript.

All authors have jointly given final approval and agreed to be accountable for all aspects of the work.

**References**